Structural Approaches to Biomass Monitoring With Multibaseline, Multifrequency, Polarimetric Interferometry

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One of the principal objectives of remote sensing is full carbon accounting in the world's forests via biomass monitoring. Traditional, proposed approaches to microwave biomass measurement in forests rely on total power, at various polarizations, usually at frequencies of 400 MHz and lower [1]. Unlike the total-power data type, interferometric amplitudes and phases taken at sufficiently diverse baselines can uniquely estimate structural parameters such as forest height and rudimentary scatterer-number-density profiles [2,3]; multifrequency, polarimetric interferometric observations further increase the accuracy and vertical spatial resolution of vegetation density profiles. Using allometric relations, which may be derived using other observations such as hyperspectral optical and lidar data, the structural parameters can be used to determine biomass.

This paper considers the role of multibaseline, multifrequency, polarimetric interferometry in measuring forest structure, which is the first step in the biomass-determination approach described above. Because interferometric sensitivity is proportional to baseline length and inversely proportional to radar altitude, varying the altitude for the fixed-baseline AIRSAR system is equivalent to multibaseline interferometry. Multialtitude polarimetric interferometric AIRSAR data were taken at C-band over 20 extensively field-measured forest sites in Central Oregon. The acquisition altitudes were 8 km, 4 km, and 2km. L-band interferometric data were also taken at vertical polarization only, but because of L-band's larger wavelength, only the 2-km altitude L-band interferometry will be considered. Simple electromagnetic scattering models [2], involving a small number of vertical-layer parameters, produce quantitative structural parameters and error estimates. Parameter estimates for 1- and 2-layer forest stands will be compared to field measurements. The relative parameter-estimate strength derived from varying interferometric baseline (altitude), frequency, and polarization will be elucidated. This structural biomass approach is complementary to the total-power. A simple calculation suggests that low-frequency, total-power approaches will be most effective at lower biomass values, and these interferometric structural approaches will be most useful in regions where many total-power biomass signatures saturate.

[1] M. L. Imhoff, "Radar Backscatter and Biomass Saturation: Ramifications for Global Biomass Inventory," *IEEE Trans. Geosci. and Rem. Sens.*, 33, 511-518, 1995.

[2] R. N. Treuhaft and P. R. Siqueira, "The Vertical Structure of Vegetated Land Surfaces from Interferometric and Polarimetric Radar," *Radio Science*, January, 2000.

[3] R. N. Treuhaft, M. Moghaddam, and B. Yoder, "Forest Vertical Structure from Multibaseline Interferometric Radar for Studying Growth and Productivity," *IGARSS97*, Singapore, 1997.